Understanding Early Jurassic ocean connectivity using Os isotopes

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Marine organic-rich sedimentary rocks (ORS) hold the key to understanding past chemical changes to the oceans. The osmium isotope system ($^{187}Os/^{188}Os$) is a particularly powerful tool for tracing these changes, and as such makes it possible to determine the effects of continental weathering, meteorite impact and mantle-derived fluxes [1].

Although the present-day seawater Os isotope composition is relatively uniform ($^{187}Os/^{188}Os$ ratio of ~ 1.06), it has varied significantly throughout geological time [2, 3]. The Jurassic was a particularly dynamic period that witnessed full-scale plate reorganisation associated with the supercontinental break-up of Pangea. The Triassic-Jurassic boundary saw the onset of Central Atlantic Magmatic Province (CAMP) volcanism as the Central Atlantic lineament began to rift. Ocean chemistry at this time was therefore subject to significant fluctuations.

The marine ORS sequence of the Sinemurian-Pliensbachian GSSP, Robin Hood's Bay, UK, was located on the margins of the shallow European epicontinental sea in relative proximity to the rifting Central Atlantic, making it an ideal candidate for studying the affect of the CAMP on seawater chemistry.

Our results indicate that there was a significant contribution of unradiogenic Os to the oceans across the Sinemurian-Pliensbachian boundary, that can only be resolved by a mantle-derived, hydrothermal Os input. Evidence for sudden increased faunal exchange between the western Tethyan and eastern Pacific Oceans at this time, suggests that initiation of flooding of the Hispanic Corridor occurred close to this boundary. Our Os data provides evidence for opening of this seaway and better constrains the timing of flooding, therefore improving our understanding of palaeogeography and ocean connectivity during the Early Jurassic.

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Arc magmas from slab to eruption: The case of Kliuchevskoy volcano

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Arc magmas are generated by a number of mantle and crustal processes. Our multidisciplinary, long-term research is aimed at deciphering these processes for a single arc volcano, Kliuchevskoy volcano in Kamchatka. Some key results of the study follow:

1) Modeling of trace element and H_2O contents in melt inclusions suggests that the primary magmas originate via hydrous flux-melting of the mantle wedge at temperatures close to the dry peridotite solidus. The role of decompression melting is minor or absent at Kliuchevskoy and other arc volcanoes built on relatively thick crust.

2) Geochemistry of high-Mg olivine suggests that primary Kliuchevskoy magmas have substantial contribution from olivine-free pyroxenite (up to 30 %), which could be formed by reaction of slab melts (or supercritical fluids) with mantle wedge peridotite.

3) Parental Kliuchevskoy melts start to crystallize as deep as the Moho boundary, and the erupted magmas reflect multi-stage and complex processes of crystallization, magma mixing and crustal assimilation. None of the Kliuchevskoy rocks analyzed thus far represent true primary melt compositions.

4) The Kliuchevskoy Holocene eruptive history is not steady-state in terms of eruption rate and geochemistry. There are two millenial cycles with major and trace element and O-Sr-Nd-Pb and U-series isotope compositions of the magmas changing gradually from more to less affected by crustal (?) assimilation. The onset of the cycles correlates with periods of enhanced volcanic activity in Kamchatka, suggesting that the extent of magma-crust interaction is inversely related to magma production rate and thus magma flux from the mantle.